INTRODUCTION TO EARTHQUAKES

- ***Seismology*** =
  - Study of earthquakes

- ***Seismologists*** =
  - Scientists who study earthquakes

- ***Earthquake*** =
  - Trembling or shaking of the earth's surface, usually as a result of the movement of rocks along a ***fault*** =
    - Fracture in the earth's crust where there has already been some movement
  - This movement creates energy in the form of seismic waves

- ***Seismic waves*** =
  - Waves of energy caused by the sudden breaking of rock within the earth
  - 2 main types of seismic waves
    - ***Surface waves*** =
      - Earthquake waves that travel on or near the surface of the earth
      - Surface waves travel slower than body waves
    - ***Body waves*** =
      - Earthquake waves that travel through the body of earth
      - 2 main types of body waves
        - » P-waves and S-waves

WAVE MOTION

Properties of Waves

- A wave can travel through a material without the material itself traveling with the wave
  - Example: Picture a duck bobbing on waves

- A wave can originate at one point and then travel outward in all directions
  - ***Focus*** =
    - Location below ground where the rupture of an earthquake begins and energy is released

The Motion of Body Waves

- ***P waves*** =
  - Also called ***primary waves***
  - A ***compressional*** earthquake wave
    - Compress and expand the material through which they travel
    - The wave vibrates parallel to the direction of the wave movement
  - First wave to reach a seismograph station during an earthquake
  - Think “push and pull”

- ***S waves*** =
  - Also called ***secondary waves***
  - ***Transverse*** earthquake waves
    - Travel inside the earth as a series of crests and troughs
    - The wave vibrates perpendicular to the direction of the wave motion
  - Travel slower than primary waves
  - Think “side to side”
  - Note: S waves CANNOT travel through liquids

Ground Motion

- P waves cause vertical shaking
- S waves cause horizontal shaking
  - Causes more damage
    - Impacts the engineering of buildings

EARTHQUAKE DETECTION

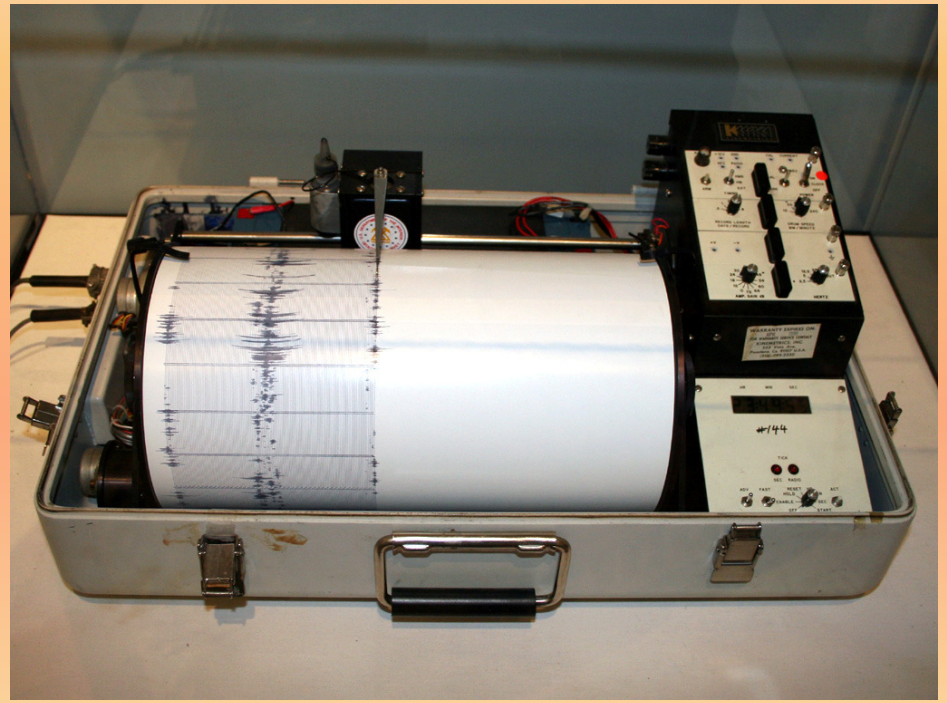
Recording earthquakes

- ***Epicenter*** =
  - The point on the surface of the earth directly above the focus of an earthquake
  - Earthquake waves are strongest here

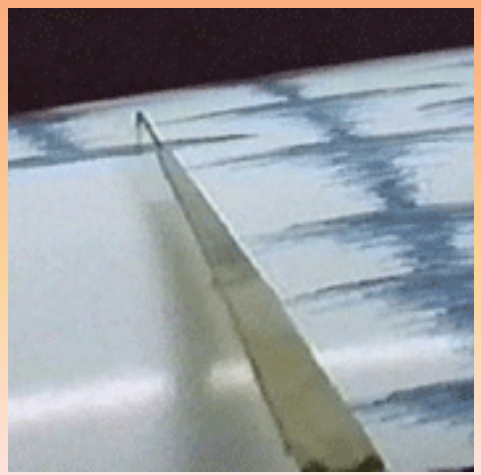
- ***Aftershock*** =
  - An earthquake wave that follows the main shock of an earthquake

- ***Seismograph*** =
  - An instrument that detects, records, and measures the vibrations produced by an earthquake

- ***Seismogram*** =
  - Record made by a seismograph
  - Paper on which earthquakes are recorded



- ***Magnitude*** =
  - A measure of the total amount of energy released at the source of the earthquake
  - Measured using ***Richter scale***
  - Determined by measuring the amplitude, or “swing” of the largest seismic wave
  - Used to compare the strength of different earthquakes around the world



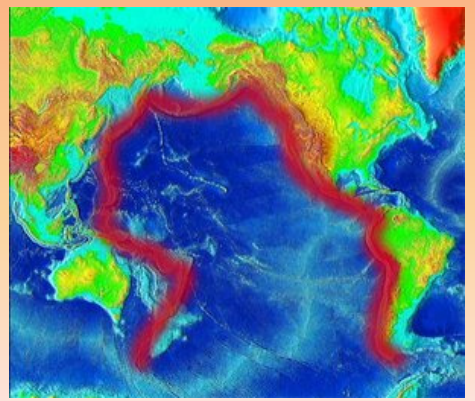
- ***Intensity*** =
  - A measure of the damage done by an earthquake
  - Determined on the basis of the earthquake's effect on people, structures, and the environment

- Many factors affect intensity
  - Distance an area is from the epicenter
  - Depth of the earthquake
  - Population density of area affected by earthquake
  - Local geology of the area (soil and rocks)
  - Type of building construction in the area
  - Duration of the shaking
  - Magnitude
- Measured using ***Modified Mercalli Intensity Scale***

Plotting earthquakes

– ***Plate tectonic theory*** =
  - Large, rigid segments of the outer part of the earth are broken into plates
  - Plates move relative to one another as they "float" over the plastic-like interior below it

– 3 main belts of earthquake activity
  - Circum-Pacific Belt (*Ring of Fire*)
  - Mediterranean-Himalayan Belt
  - Mid-oceanic ridges
    – Including Mid-Atlantic Ridge



USING EARTHQUAKES TO STUDY EARTH'S INTERIOR

Dividing the Earth's Interior by Composition

The earth can be divided into 3 concentric layers

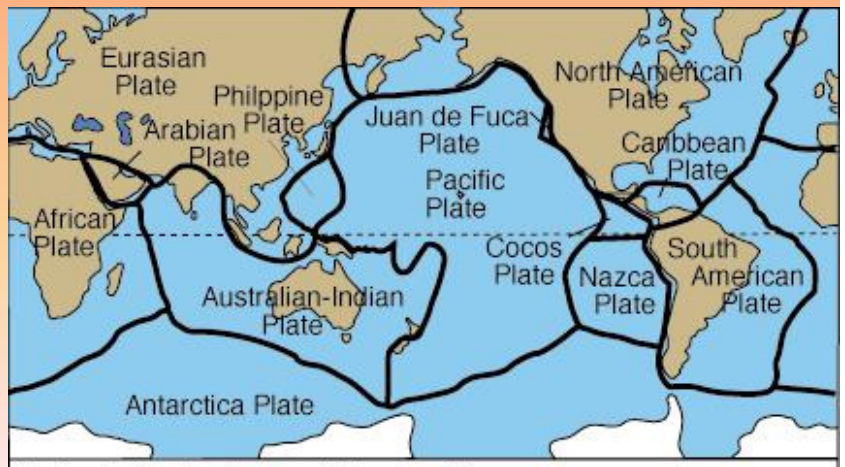
- ***Crust*** =
  - Outer layer, lowest density
  - Coolest
  - Rigid, composed of variety of rocks
  - 2 types
    - ***Oceanic crust*** =
      - Lies beneath ocean waters
      - 5 to 10 km thick
    - ***Continental crust*** =
      - Contains landmasses
      - Ranges from 15 to 70 km

- ***Mantle*** =
  - Extends from base of crust to depth of about 2900 km
  - Largest of the 3 layers

- ***Core*** =
  - Beneath the mantle
  - ***Outer core*** =
    - Molten iron (liquid)
    - S-waves cannot be transmitted through the core
      - Will not pass through liquid
  - ***Inner core*** =
    - Solid nickel and iron

Dividing the Earth's Interior by Physical Properties

- The interaction of the top two layers is primarily responsible for the formation of earthquakes, volcanoes, and mountains
- ***Lithosphere*** =
  - Crust and upper mantle
  - Can break under pressure
  - Broken into plates
    - Always moving (2-20 cm per year)



Major tectonic plates of the world.

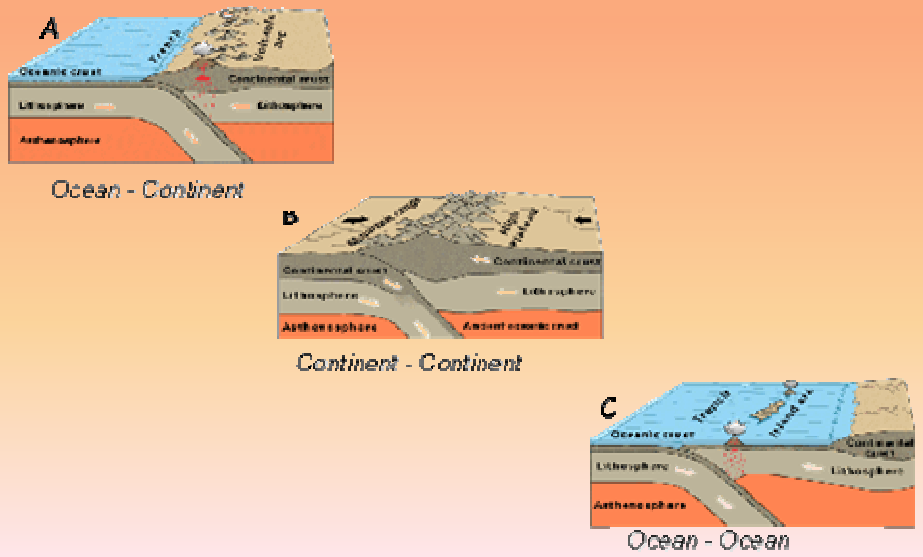
- ***Asthenosphere*** =
  - Layer of the mantle that lies directly below the lithosphere
  - Increasing temperature and pressure
  - Solid, but flows, like taffy
    - Allows lithospheric plates to “float” and move

PLATE MOVEMENT AND FAULTS

- ***Plate boundary*** =
  - A place where pieces of the broken lithosphere meet
  - Boundary types include
    - Convergent
      - Colliding
    - Divergent
      - Spreading
    - Transform
      - Sliding

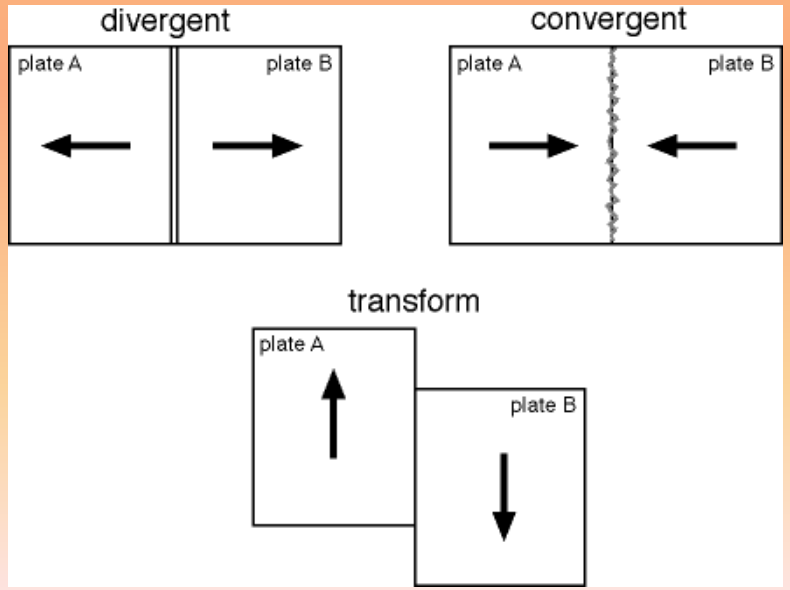
- ***Convergent Plate Boundaries*** =
  - Occur when edges of continental or oceanic plates move toward each other and collide
  - If 2 continental plates collide
    - Density is fairly equal
    - Mountains form

- If oceanic and continental plates collide
  - Oceanic plate will slide under continental and bend downward
- If 2 oceanic plates collide
  - Older (more dense) plate slides under newer (less dense) plate



- ***Divergent plate boundaries*** =
  - Where plates separate
    - Rising molten rock beneath the plate contributes heat that leads to the break
  - ***Mid-ocean ridge*** =
    - Mountain-like landform that develops when plates separate and water enters where the plates split

- ***Transform plate boundaries*** =
  - When plates slide past each other
  - No new land is formed
  - BUT
    - Destructive earthquakes are common near transform plate boundaries!



- All rocks are weakest where previous fractures exist
  - More common along plate boundaries
  - ***Faults*** =
    - Fracture in the earth's crust where there has already been some movement
    - Example
      - San Andreas Fault in California
    - Measurable movements of rocks along a fault is a direct cause of earthquakes

- Note: If you apply force to a stick, it bends first and then breaks.
- Apply force to a rock and the rock will store energy.
- When the strength of the force becomes greater than the strength of the rock, the rock will break, and an earthquake will occur.